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54 **Electrical crimp type termination for aluminium wire.**

57 **Electrical crimp type termination for aluminium wire** which includes interposed between the inside surface of a relatively hard electrically conductive crimp barrel (12b) and the outside surface of the aluminium wire (15) a sleeve (14) made of a relatively soft electrically conductive material and having a bore coated with a thin hard brittle layer (18), the coated bore being adapted to fit over the aluminium wire (15) and the outside surface of the sleeve (14) being adapted to fit into the crimp barrel (12b), so that crimping the crimp barrel (12b) causes the sleeve (14) to be crimped with the material of the crimp barrel (12b) and the aluminium wire (15), thereby forming a strong reliable electrical joint by breaking the coated layer (18) into many sharp particles to bite through and abrade the oxide surface of the aluminium wire (15) to bring clean aluminium into intimate electrical contact with clean sleeve material and by additionally bringing the relatively hard barrel material into intimate electrical contact with the relatively soft sleeve material.

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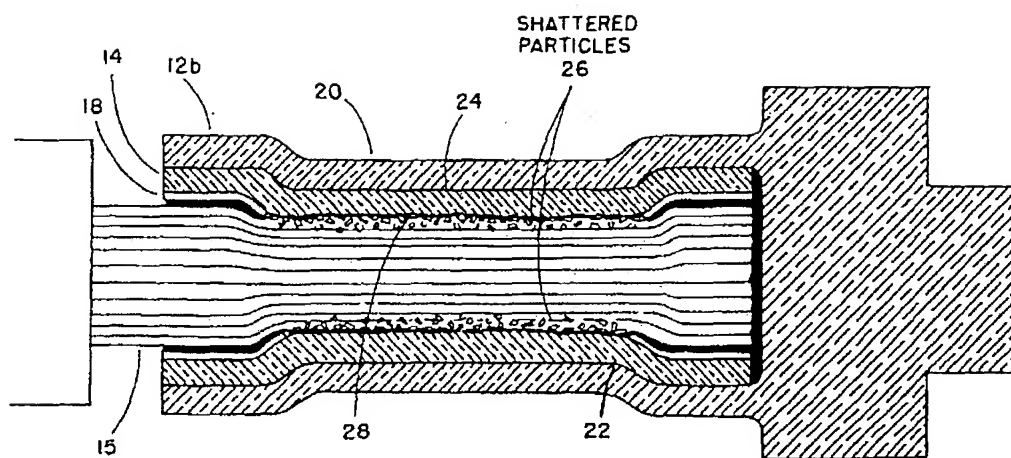


FIG. 3

Electrical crimp type termination for aluminium wire

The present invention relates to an electrical crimp type termination for aluminium wire including an electrically conductive crimp barrel associated with means interposed between the inside surface of the crimp barrel and the outside surface of the aluminium wire to form a strong reliable electrical joint when crimped with the material of the crimp barrel and the aluminium wire.

Aluminium wire typically is only about 60 % as electrically conductive as copper wire of the same diameter but it is about one third the specific weight of copper and much less expensive. There are thus economic and technical advantages to using aluminium wire as electrical conductors. As a result aluminium wire has been used in some electrical wiring applications where copper wire might normally have been used.

However, aluminium wire has fallen out of favor as electrical conductor material due to the unreliability of electrical connections made to aluminium. Specifically, a non-electrically conductive aluminium oxide rapidly forms on the surface of clean aluminium. Thus when an electrical joint is made to aluminium wire, some easy, convenient, inexpensive and quick means must be employed to break up the surface non-conductive aluminium oxide to expose the underlying aluminium and to simultaneously make a reliable electrical joint before oxide has a chance to reform over the newly cleaned surfaces. The prior art means include copper alloy terminations, where the word termination includes connectors and the like, for aluminium wire having crimp barrels whose inner diameters include internal protrusions or perforated sleeves which, upon crimping the connector barrel, bite into the aluminium wire surface to break up and penetrate the oxide layer to bring clean aluminium into immediate and intimate electrical contact with the termination material. Another means used to make electrical connection to aluminium wire has included a hard brittle plating, usually nickel, on the crimp barrel interior surface. When the barrel is crimped onto the aluminium wire the brittle plating breaks up into a large

plurality of small hard sharp electrically conductive particles to expose clean material beneath and also to abrade and bite through the oxide layer into and to expose clean aluminium which comes into immediate and intimate electrical contact with  
5 the connector.

Wire terminations are usually made of a relatively hard electrically conductive material, such as brass, copper, steel, bronze or beryllium copper, having a yield strength in excess of  $1000 \text{ kg/cm}^2$ . Unfortunately, the prior art means do  
10 not provide long term reliable electrical joints between aluminium and such relatively hard materials so that high resistance joints sometimes result producing a potentially dangerous condition. Primarily because of this problem, aluminium wire has fallen into disfavor as electrical conductor material. This is un-  
15 fortunate in light of the current rising price and uncertain supply of copper.

The present invention overcomes the disadvantages and limitations of the prior art arrangements by providing an electrical crimp type termination for aluminium wire which in-  
20 cludes interposed between the inside surface of a relatively hard electrically conductive crimp barrel and the outside surface of the aluminium wire a sleeve made of a relatively soft electrically conductive material and having a bore coated with a thin hard brittle layer, the coated bore being adapted to fit  
25 over the aluminium wire and the outside surface of the sleeve being adapted to fit into the crimp barrel, so that crimping the crimp barrel causes the sleeve to be crimped with the material of the crimp barrel and the aluminium wire, thereby forming a strong reliable electrical joint by breaking the coated layer  
30 into many sharp particles to bite through and abrade the oxide surface of the aluminium wire to bring clean aluminium into intimate electrical contact with clean sleeve material and by additionally bringing the relatively hard barrel material into intimate electrical contact with the relatively soft sleeve material.  
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One way of carrying out the invention is described in detail below with reference to the drawings which illustrate one specific embodiment, in which :



Fig. 1 is an exploded isometric view of a crimp type connector termination made according to the present invention.

Fig. 2 is a cross section of the connector of Fig. 1 taken along its longitudinal axis.

5 Fig. 3 is a partial cross section of the connector termination of Fig. 1 as crimped on an aluminium wire and taken along the wire longitudinal axis.

Referring first to Figs. 1 and 2, a termination such as connector 10 made according to the present invention is comprised of a pin contact member 12 and a sleeve 14. Pin contact member 12 is similar or identical to the pin contact member known in the electrical connector art which terminates a single electrical lead or wire and which is positioned in a block of insulating material, normally in spaced relationship with a plurality of like pin contact members, to comprise an electrical connector. Pin contact member 12 is designed to mate with a standard socket contact member (not shown) which is similarly positioned in a second block of insulating material in spaced relationship with a plurality of socket contact members to comprise the mating electrical connector. As will be clear to one skilled in the art, the socket contact members can incorporate the means of the present invention. Pin contact member 12 is a crimp connection device which here is comprised of a pin end 12a, a barrel end 12b and an intermediate collar 12c. Pin contact member 12 is preferably formed in the usual manner, that is, machined from a relatively hard electrically conductive rodstock such as brass or beryllium copper as is standard in the art. Barrel end 12b has an internal round crimpwell 12d.

30 A sleeve 14 has an external dimension 14a which fits easily within crimpwell 12d of pin contact member 12. Aluminium wire 15, either a single strand or multistranded wire, has an external dimension such that wire 15 fits easily into bore 14b of sleeve 14. Sleeve 14 may be machined cylinder or, preferably, made of sheet stock which is rolled into a cylindrical shape with seam 14c. Sleeve 14 is made of a relatively soft electrical material such as copper alloy CA145, annealed to a DPH hardness of 65 maximum if machined or copper alloy CA102 at 1/8 temper if rolled.

Bore 14b of sleeve 14 has deposited thereon a hard brittle



and preferably continuous coating 18 such as metal which is suitably electroplated. Coating 18 not only provides a frangible means which will break up into a large number of small sharp particles when sleeve 14 is crimped but it also protects the underlying metal from corrosion and other contamination so that when coating 18 is fractured a clean pure metallic underlayer is exposed.

In embodiments of the invention actually made, coating 18 was nickel applied by a standard electroless nickel plating process at a thickness of 13/1000 mm to 14/1000 mm. As might be expected, the hard brittle coating can be applied by other coating processes such as electrolytic plating, metal cladding and vapor deposition, for example. Of course, another coating than nickel can be used to practice the invention, so long as the coating is hard and brittle, such as other brittle metals, ceramics, enamels and the like.

Refer now to Fig. 3 where an aluminium wire 15 is seen assembled within sleeve 14 sandwiched within crimpwell 12d between the interior surface of the crimp barrel 12b and the exterior surface of the wire. Crimp barrel 12b is crimped in the conventional manner, producing crimp deformation 20 and simultaneously crimping sleeve 14 in a crimp deformation 22. As a result, pin contact member 12 is electrically crimped and joined to sleeve 14 at interface 24. Simultaneously, coating 18 is shattered in a large plurality of sharp particles 26 which dig into and through the aluminium oxide layer to provide electrical communication between wire 15 and sleeve 14 (It should be noted that coating 18 and particles 26 are shown exaggerated in size for clarity in this figure). When coating 18 is shattered, clean pure underlying sleeve material is exposed. The shattered particles 26 also abrade the surface oxide layer of wire 15 to expose clean pure aluminium which, by crimping, is brought into high pressure intimate electrical contact with the newly exposed sleeve material. The result is the formation of an intermetallic and cold welding of the aluminium to the sleeve material at interface 28, resulting in a strong reliable electrically sound joint.

Although the invention has been here embodied in a pin connector, it should be obvious that it can be used in other terminations such as, for example, socket connectors, spade lugs and the like.



Claims :

1. An electrical crimp type termination for aluminium wire including an electrically conductive crimp barrel (12b) associated with means (14,18) interposed between the inside surface of the crimp barrel (12b) and the outside surface of the aluminium wire (15) to form a strong reliable electrical joint when crimped with the material of the crimp barrel (12b) and the aluminium wire (15), characterized in that said interposed means (14,18) comprises a sleeve (14) made of a relatively soft electrically conductive material and having a bore (14b) coated with a thin hard brittle layer (18), the coated bore (14b) being adapted to fit over the aluminium wire (15) and the outside surface of the sleeve (14) being adapted to fit into the crimp barrel (12b).

2. A termination as claimed in claim 1, characterized in that said layer (18) is of an electrically conductive material.

3. A termination as claimed in claim 1 or 2, characterized in that the sleeve material is relatively soft copper.

4. A termination as claimed in claim 1 or 2, characterized in that said layer (18) is nickel plated on the surface of the sleeve bore (14b).

5. A termination as claimed in claim 1 or 2, characterized in that the crimp barrel 12b is made of a material having a yield strength in excess of about  $1000 \text{ kg/cm}^2$ .

6. A termination as claimed in claim 5, characterized in that the crimp barrel (12b) is formed of a material chosen from the group consisting of brass, copper, steel, bronze and beryllium copper.





European Patent  
Office

# EUROPEAN SEARCH REPORT

001886

Application number

EP 80 40 1

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. '1)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	US - A - 3 895 851 (AMP) * Column 1, lines 56-68; figures * --	1,2	H 01 R 4/62
A	US - A - 2 815 497 (AMP) * Column 8, line 62 - column 10, line 23; figures * --	1,4,6	
A	PRODUCT ENGINEERING, vol. 45, nr. 12, December 1974 NEW YORK (US) F. YEAPLE: "New designs for aluminium motors include fool-proof connectors", pages 19-22 * Page 21, first half; figures * ----		
			TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
			H 01 R 4/62 4/20 4/18
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
<input checked="" type="checkbox"/> The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	12.08.1980	RAMBOER	

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